

PATENT SPECIFICATION

(11) 1439 940

1439940

- (21) Application No. 55719/72 (22) Filed 1 Dec. 1972
 (23) Complete Specification filed 30 Nov. 1973
 (44) Complete Specification published 16 June 1976
 (51) INT CL² E05D 15/10
 (52) Index at acceptance
 EIJ 301 393 405 407 4925 4931 4974
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(54) DOOR MECHANISMS

(71) We, WESTINGHOUSE BRAKE AND SIGNAL COMPANY LIMITED, a Company incorporated under the Laws of Great Britain, of 3, John Street, London, WC1N 2ES, formerly of 82, York Way, King's Cross, London, N.1. 9AJ England, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to door mechanisms and relates particularly to a sliding door mechanism which enables a door to be moved in a direction parallel to its plane and in a direction transverse thereto, especially but not exclusively for use on rail vehicles.

According to the present invention there is provided a sliding plug door mechanism including a track arrangement by means of which an upper part of a door leaf is supported and guided to execute in operation a slide and plug combined motion parallel to and transverse to the plane of the door, and an arm pivoted about a vertical axis at a point on a fixture which is fixed relative to the door, the arm extending between a lower part of the same door leaf and the fixture so that, during the initial opening movement of the door leaf, a part of the arm is constrained by an abutment on the door leaf to pivot relative thereto but, during subsequent opening movement, said part becomes disengaged from the abutment to slidably engage the lower part of the door leaf to thereby constrain said lower part to execute in operation a similar combined motion concurrently with the first said motion.

The said arm may have another pivot point which, on attainment of a pre-determined point of the transverse motion of the door leaf and consequent pivoting of the arm, is freed to move under the constraint of a further track comprised in said constraining means, whereby to permit further motion of the door leaf in the plane thereof.

Preferably, the further track is arranged to move with the door leaf and the arm carries a part which engages with the track so that

the other pivot point is movable along the track after attainment of said pre-determined point of the transverse motion.

The further track may include a stop which engages said arm substantially to prevent such motion of the other pivot point up to said predetermined point of the transverse motion.

The first mentioned track arrangement may include a support track the direction of which is at an angle other than perpendicular to the door leaf to enable the transverse door leaf motion to include an upward component over at least a part of its travel.

Preferably the said part of its travel of the door leaf is up to attainment of the said predetermined point of the transverse motion.

In the first mentioned track arrangement a supporting track for carrying the door leaf in a direction transverse thereto may be carried by first traversing means supported by second traversing means on a main track which extends parallel to the door leaf, and guide means may be provided for constraining the motion of the door leaf permitted by said tracks to said combined motion.

In the foregoing where mention is made of a direction parallel to the plane of the door leaf, in the event of the motion being over a curved path, for example, the parallel to the door leaf may be taken as a tangent to the instantaneous radius of the direction of motion.

In order that the invention may be more clearly understood and readily carried into effect, the same will be further described by way of example with reference to the accompanying drawings of which,

Figure 1 and Figure 2 illustrate respectively end and underside views of a sliding door mechanism embracing one embodiment of the present invention; and

Figure 3 illustrates a modification of a detail of Figures 1 and 2.

Referring to the drawings, the mechanism illustrated is intended for use in conjunction with a sliding door of a rail vehicle and in particular to doors of a type which may be described as "plug" doors. The door leaves of

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such doors have a motion whereby on opening they move away from the side of the vehicle and run along the side of the vehicle, the reverse motion taking place on closing, the final direction of closing motion being substantially normal to the side of the vehicle. Hence the expression "plug", the door leaves effectively plugging the doorway. In Figures 1 and 2, only one door leaf is shown and this is denoted by reference 1. It will however be understood that at least a further door leaf may be provided which operates in unison with the one door leaf and is supported upon the same main track. The door leaf 1 is carried by a supporting track 2 which is bolted securely to a point in the proximity of the innermost upper edge of the door leaf by means of a flange 3. The supporting track 2 is of channel section and is supported on two rollers 4 and 5 which are rollingly retained in the track 2 as shown in Figure 1. These rollers are carried on a trolley 6 which hangs by means of further rollers 10 rollingly retained in main tracks 8 and 9 which are suspended beneath the head 11 of the door frame of the vehicle. The track 2 and the rollers 4 and 5 form a first traversing means, and the tracks 8 and 9, and the rollers 10 form a second traversing means. As is most clearly seen from Figure 2, the supporting track 2 has attached to its innermost end, a rigid arm 12 which is fixed to a further projecting member 13 extending from the innermost corner of the above mentioned trolley 6. The member 13 is of channel section similar to the supporting track 2 and the trolley has a third roller 14 which is rollingly retained therein similarly to the rollers 4 and 5 referred to above. It will be seen that by means of this arrangement, which extends towards a projection of the centre of gravity of the door leaf, the moment of the downward weight about the supporting track 2 is counteracted by the arm of the arm 12 also acting about the track 2.

The door track arrangement also includes a guide track 15 which is seen in Figure 1 and Figure 2 and within which a finger 17 carried by the innermost extremity of the track 2 is retained. This guide track is arranged to be curved and lies in a plane which is parallel to a plane through the length of track 2. Since the guide track is carried also by the head of the door frame, it constrains the motion of the door leaf to a path which is determined by the configuration of the guide track.

Hitherto, no mention has been made of the lower edge of the door leaf or the manner of which this is steadied against inward or outward pressures. For this purpose, a fixture 18 is provided in the vehicle preferably beneath the passenger entry step of the vehicle and the fixture carries a pivoted arm 19, the fixture 18 being fixed relative to the

vehicle's door. This arm 19 is cranked in the manner shown in Figure 2, and carries at its outer end a pair of rollers 21. The rollers 21 run in a track 20 which is carried in the body of the door leaf 1. At a precisely determined position within the track there is also included a stop member 22 which whilst it engages with an abutment 19' on the arm 19 over a range of positions of the door leaf over a further range of positions of the door leaf 1 and consequential pivoted positions of the arm 19, the stop 22 is permitted to pass between the two rollers 21 and the abutment 19' such that thereafter the rollers 21 can travel along the track 20 unimpeded.

Between pins 23 and 24 on the arm 19 and the fixture 18 respectively, there is provided a tension spring 25 for biasing arm 19 to the door-closed position, the latter being the position shown in which the door leaf is thus urged against a seal denoted by reference 26.

Actuator means (not shown) for driving the door leaf 1 forms no part of the present invention and may be of any suitable form to operate the door leaf 1 by longitudinal movement of via an actuator rod 27 (Figure 2).

In operation of the sliding door mechanism, starting from the closed position shown, in order to open the door leaves, tension is applied by the actuator means (not shown) to the rod 27 and the door leaf 1 whose weight is supported largely by the tracks 8 and 9 tends to travel along these tracks with the trolley 6. Since however motions along the tracks 8 and 9 can only be accompanied by motion of the finger 17 in guide track 15, the door leaf 1 is constrained to execute in addition to a component of motion parallel to its own plane, a further component of motion which is transverse to the plane of the door leaf 1. The door leaf 1 therefore moves towards a position which is shown in phantom in Figure 1. It will be seen that the latter component of motion also includes motion in an upward direction by virtue of the angle at which the track 2 is fixed to the door leaf 1. The radius of motion of the roller 21 about the pivot of the arm on the fixture 18, is a radius which is substantially identical to the radius of the curve of the guide track 15 so that by virtue of the stop 22, the arm 19 merely acts as a means whereby the lower part of the door leaf 1 is steadied against transverse motion other than that corresponding to the motion dictated by the guide track 15. However, at the extremity of the transverse motion of the door leaf 1 as dictated by the guide track 15, the stop 22 disengages from the abutment 19' which has borne against it during the transverse motion of the door leaf 1 and the roller 21 is then released for motion along the track 20 which is carried by the door leaf 1. Accordingly,

the door leaf 1 having been lifted upwards and outwards from the side of the vehicle, is then constrained to move parallel to the side of the vehicle to the fully open position.

- 5 During closure of the door, a longitudinal thrust is applied by the actuator means (not shown) to the rod 27 and the door leaf 1 first executes a motion which is parallel to the side of the vehicle and its own plane and subsequently, the stop 22 engages appropriately with the abutment 19' and thereafter the arm 19 executes a circular motion corresponding to the motion dictated by the guide track 15 until the door leaf 1 is withdrawn into its closed position as shown in the drawings.

- 10 In a minor modification of the arrangement shown in Figures 1 and 2, the arm 19 may have associated therewith in place of the spring 25 as shown in Figures 1 and 2, a pneumatically operable spring plunger device denoted by reference 28 in Figure 3. By means of this device 28 and a suitable timing control valve (not shown), air pressure may be applied to one side of a piston 29 in a cylinder 30 to assist the thrust of a light spring 31 on attainment of the fully closed position of the doors. By such means, it is possible to enable an object (not shown) trapped by the shutting of the door 1 to be easily removed but for the door leaf 1 to be effectively "locked" shut by the air supply once the fully closed position has been attained.

- 35 Whilst in the above described arrangement embodying the invention, the supporting track 2 is arranged at such an angle that the door leaf 1 is lifted upwards and outwards, clearly the track 2 could be arranged to be normal or at some other angle to the door leaf and in these circumstances the upward component of motion might not be included. Clearly, it would still ordinarily be necessary in such circumstances for the guide track 15 to be arranged in a plane which is parallel to the plane including the length of the track 2 and also the arm 19 would be arranged to swing in a similarly parallel plane to execute a motion which mimics the motion dictated to the finger 17 by the track 15.

WHAT WE CLAIM IS:—

1. A sliding plug door mechanism including a track arrangement by means of which an upper part of a door leaf is supported and guided to execute in operation a slide and plug combined motion parallel to and transverse to the plane of the door, and an arm pivoted about a vertical axis at a point on a fixture which is fixed relative to the door, the arm extending between a lower part of the same door leaf and the fixture so that, during the initial opening movement of the door leaf, a part of the arm is constrained

by an abutment on the door leaf to pivot relative thereto but, during subsequent opening movement, said part becomes disengaged from the abutment to slidably engage the lower part of the door leaf to thereby constrain said lower part to execute in operation a similar combined motion concurrently with the first said motion.

2. A mechanism as claimed in Claim 1, the said part of the arm comprising another pivot point which, on attainment of a pre-determined point of the transverse motion of the door leaf and consequent pivoting of the arm, is free to move under the constraint of a further motion of the door leaf in the plane thereof.

3. A mechanism as claimed in Claim 2, said further track being arranged to move with the door leaf and the arm carrying a part which engages with the further track so that the other pivot point is movable along the track after attainment of said pre-determined point of the transverse motion.

4. A mechanism as claimed in any preceding Claim, wherein said track arrangement includes a support track the direction of which is at an angle other than perpendicular to the door to enable the transverse door leaf motion to include an upward component over at least a part of its travel.

5. A mechanism as claimed in Claim 4, as directly or indirectly dependent on claim 2, the said part of the travel of the door leaf being up to attainment of said pre-determined point of the transverse motion.

6. A mechanism as claimed in any preceding claim wherein in the track arrangement a supporting track for carrying the door leaf in a direction transverse thereto is carried by first traversing means supported by second traversing means on a main track which extends parallel to the door, and further comprising guide means for constraining the motion of the door leaf permitted by said tracks to said combined motion.

7. A mechanism as claimed in Claim 6, wherein the door leaf is supported by the track arrangement at a point in the proximity of the edge of the door leaf which leads when closing, the second traversing means extending therefrom towards a vertical projection of the centre of gravity of the door leaf so that the track arrangement can lie behind a door opening.

8. A mechanism as claimed in any preceding claim wherein said pivoted arm is a part of a spring-loaded toggle mechanism which, in operation and when the door is open, is urged to its door-open position and, when the door is closed, is urged to its door-closed position.

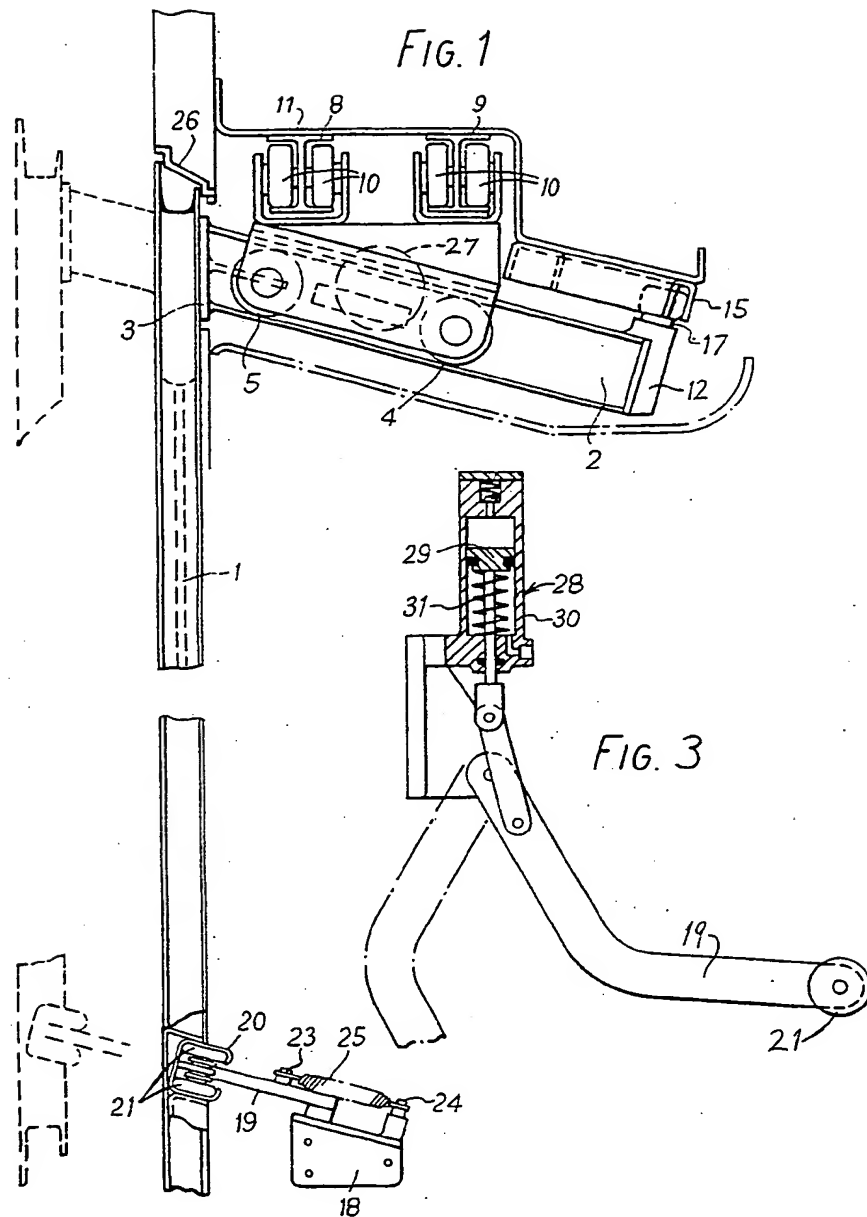
9. A mechanism as claimed in Claim 8, said toggle mechanism including a fluid

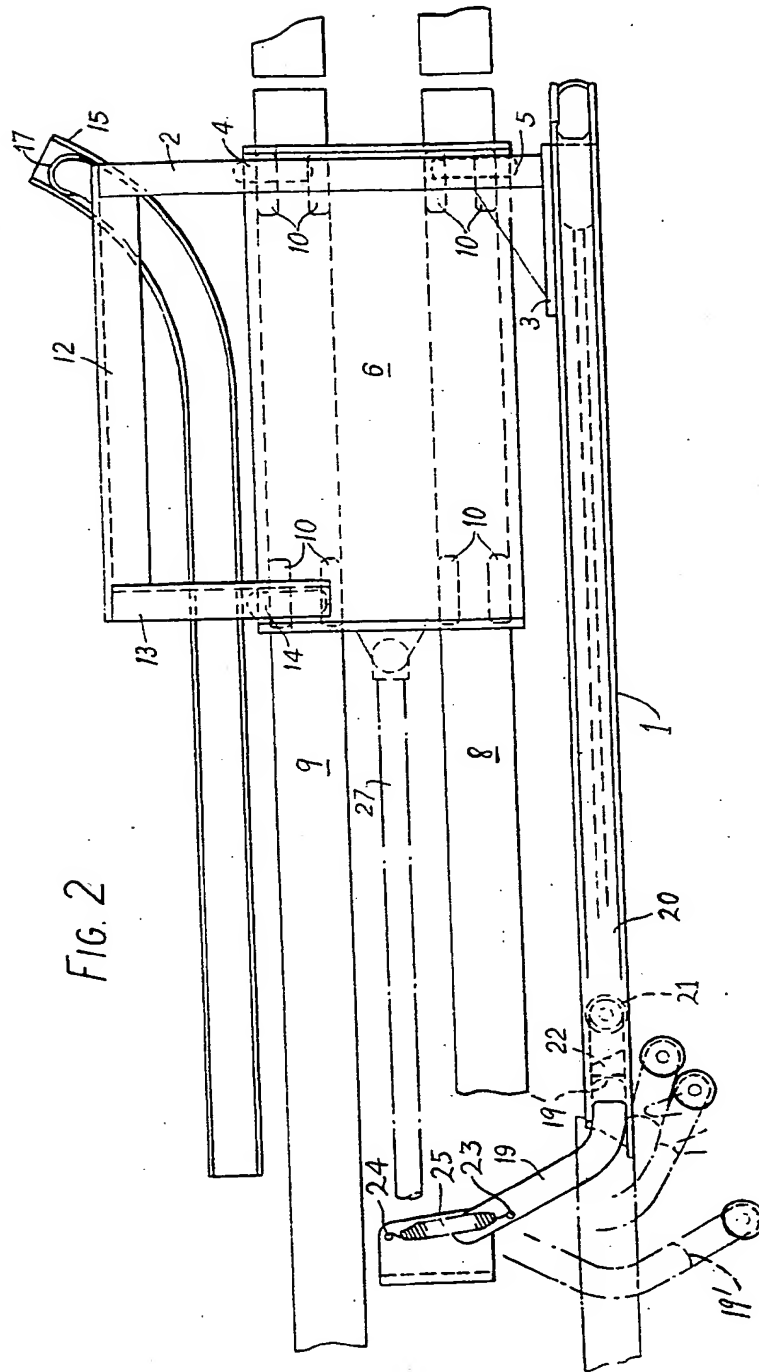
operable device for selectively applying locking forces to the toggle mechanism in the said door-closed position. 2, or Figures 1, 2 and 3 of the accompanying drawings.

10. A mechanism substantially as described
5 herein with reference to Figure 1 and Figure

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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1976.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.





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